Effect of Internal Radius and Shorter Horizontal Scale Bathymetric Variations on Coastal Dynamics

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LONG-TERM GOALS

Numerical models of coastal circulation need to be rigorously tested against observations if they are to be used for prediction. As higher spatial detail is desired in a flow prediction, finer resolution grids are used with higher resolution bottom topography. It is important to know how these models represent processes at small spatial scale. It is important to know how fine the grid must be to represent circulation over variable bottom topography. It is important to know what topographic features need to be resolved in model calculations and which can be smoothed away. I am addressing these questions of model resolution and model testing while working on the dynamics of coastal flow in places where observations exist.

OBJECTIVES

This effort has two objectives. The first is to analyze the effect of smoothing bottom topography or increasing grid spacing on the model derived circulation. The specific case is a realistic setup for Astoria Canyon (on the US Northwest coast) for which flow and temperature observations exist for comparison. The second objective is to hold a two day workshop to design a program of observations to test numerical model predictions in locations with steep and small scale bathymetry. As part of this test, we will design veracity measures that can quantitatively assess model quality to avoid the more qualitative assessment based on similarities of graphs. Because of the interest of ONR in water turbulence and the bottom boundary layer, we will invite experts in these subjects to the workshop and will consider test sites where turbulence generation will be large to see how these parts of the predictive model behave.

APPROACH

The approach for task one is make calculations with an existing model of Astoria Canyon which uses the Regional Ocean Modeling System (ROMS) designed by Dale Haidvogel and co-workers. This project is a joint effort involving Barbara Hickey (U. Washington), Susan E. Allen (U. British Columbia) and Dale Haidvogel (Rutgers U.). The existing Astoria Model has a grid spacing of about 0.3 km and includes a shelf region of about 100 km on a side. Observed stratification sets the initial conditions. Surface wind stress from FNMOC at 6 hourly intervals for the months of May and June are

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14. ABSTRACT
Numerical models of coastal circulation need to be rigorously tested against observations if they are to be used for prediction. As higher spatial detail is desired in a flow prediction, finer resolution grids are used with higher resolution bottom topography. It is important to know how these models represent processes at small spatial scale. It is important to know how fine the grid must be to represent circulation over variable bottom topography. It is important to know what topographic features need to be resolved in model calculations and which can be smoothed away. I am addressing these questions of model resolution and model testing while working on the dynamics of coastal flow in places where observations exist.

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used to drive the model to compare to observations made by Hickey within the canyon in May – August, 1983 (only the first few weeks are used for comparison at this point).

Results of the realistic simulation were not satisfactory because the model circulation was more horizontal than indicated by the observations and the temperature changes in response to upwelling wind pulses was weak by a factor of about 5–10. Analysis by Susan Allen shows that the vertical advection of temperature is erroneously small in regions of strong bottom slope. A variety of tests (stronger winds, changes in friction parameters, changes in the friction submodel and the like) did not change the model response. Thus the focus on model behavior for different resolution and bottom slope.

Mike Dinniman is responsible for running ROMS for the various choices for grid resolution and bottom topography.

The approach for the second task is to invite around 10 scientists to meet for 2 days to discuss the issues of coastal circulation in regions with small scale, steep topography and how the circulation in these regions can be represented in coastal models. The important issue to discuss is where one might site a measurement program and what measurements to take so that observations could verify model simulations. This region would include a steep subsurface bank or a submarine canyon or an escarpment which would be a strong test of model solutions. A component of this work would be to design, or choose from the meteorological literature, measures (metrics) for model-data comparison so that strong statements can be made on the quality of the model solution.

WORK COMPLETED

We have run simulations for Astoria with smoothed bathymetry. We have run cases with a generic canyon shape having approximately the dimensions of Astoria (about 50% wider, but other parameter the same) cut into a uniform continental shelf. Wind forcing is the same as used for the Astoria realistic case. The less steep, simpler generic canyon has a larger, more realistic temperature change than does the steep topography realistic case.

The workshop was deferred until decisions could be made by the program managers on its purpose.

RESULTS

We have learned that geometrical factors make a difference in the upwelling response. Temperature changes are larger, but still less than observed, over a generic canyon of the dimensions of Astoria (except wider) compared to a realistic Astoria. The generic result is stronger than that for a smoothed version of Astoria topography, so the details of the coastal topography or the orientation or detailed shape of the canyon are important in the circulation response.

IMPACT/APPLICATIONS

These results will be used to develop guidelines for the use of coastal circulation predictive models.

TRANSITIONS

We are providing results to Dr. Dale Haidvogel and Dr. Hernan Arango to keep them informed of the behavior of the ROMS model. We also report model coding errors to Dr. Arango so that future versions of ROMS will not have these errors.

RELATED PROJECTS

There are no related ONR funded projects.